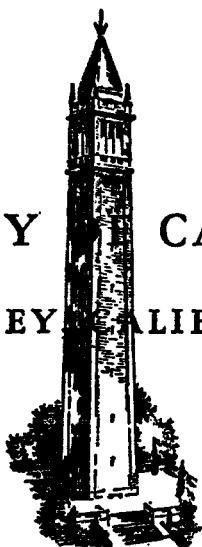


# SPACE SCIENCES LABORATORY

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University of California  
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CONSOLIDATED QUARTERLY  
PROGRESS REPORT

for period ending August 1, 1964

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## FOREWARD

The Consolidated Quarterly Report covers all research projects directly administered by the Space Sciences Laboratory and a few associated with the program of the Laboratory but which for convenience largely are formally administered by other departmental offices. The broad multi-disciplinary program involves the physical, biological, engineering, and social sciences. It is seen in the listing of the personnel that a large number of faculty members participate in the program as faculty investigators and a considerable number of students are engaged in the projects as part of the work for advanced degrees. A small number of students are engaged in the work of the Laboratory in other capacities.

The wide variety of projects are not unrelated to one another but group into areas of space science. The N. A. S. A. grant, NsG 243-62, titled for the sake of brevity as "General Support", serves as a core of funding to maintain continuity and to initiate new research. When a new study proves to be fruitful and of substantial magnitude it is formulated as a distinct project and attempts are made to obtain the larger funding needed under a separate proposal. Thus work from the General Support area passes to a new grant or contract. A large portion of the General Support grant is allocated to the work in social sciences. The studies in this area cover a wide variety of problems in management, operations analyses and decision making, the economic impact of the space program, and the international import of the space program.

The projects in the physical, biological, and engineering sciences group into areas of space science as follows:

1. Atmospheric Science (Planetary Atmospheres). -- The studies are directed toward determining the composition of the atmospheres of the planets

from microwave and infrared spectra and understanding phenomena in the Earth's ionosphere and magnetosphere.

Nonr 222(54); NsG 243-62; NsG 255-62

2. Lunar Structure. -- The work in this area consists of analysis of the types and distribution of types of lunar craters, the study of the interaction of the Moon and the solar wind and attendant magnetic effects, a study of the application of neutron scattering and neutron induced reactions to the analysis of the elemental composition of the surface. The last of these is of more general interest as a possible technique for remote analysis of planetary surfaces.

NsG 452; NsG 243-62

3. Fields and Particles. -- The projects in this area consist of space probe and satellite experiments to study the energy spectra of particles in the interplanetary region, balloon borne experiments to study interaction of energetic particles with the Earth's atmosphere, ground-based studies of the geomagnetic field and the association of geomagnetic micropulsations with processes in the interplanetary medium and in the Earth's ionosphere and magnetosphere.

NAS 5-2989; NAS 5-2222; NSF GP-2252;  
Nonr 222(89); CGS 1167(G); NSF GP-1175

4. Exobiology. -- This group of projects is concerned with the fundamental chemistry of living systems as a basis of developing an understanding of organic evolution on a cosmic scale, the search for organic molecules in meteorites and in early terrestrial rocks, the detection of microorganisms in the Earth's upper atmosphere, the biochemical behavior of microorganisms in simulated planetary (other than Earth) environments, and spectroscopic techniques for detecting organic molecules in the surface of Mars and areas

of the surface of Mars that are favorable to the existence of life. This area of work is particularly interdisciplinary involving as it does the combination of physical, chemical, and biological techniques and studies with engineering and instrumentation research. The infrared spectroscopic studies are conducted in close association with the microwave and infrared work on planetary atmospheres.

NsG 101-61; NsG 479; NsG 126-61  
NsG 104-61; NASr 220

5. Space Physiology. -- The projects on space physiology are motivated by the need for more extensive knowledge of the effects of the space environment on human beings. One project, conducted in close association with the Bioscience Division of Ames Research Center, has as its objective the development of sensors for studying certain physiological functions and parameters and the more precise study of such functions in mammals to establish base line data for flight experiments. The second project deals with the effects of sensory deprivation on biochemical processes in the brain, a matter of considerable concern in prolonged space flights.

NsG 600; NsG 154-61

6. Engineering Sciences. -- This constitutes a broad interdisciplinary area in itself. The major portion of the program is made up of studies conducted by members of the Division of Aerosciences of the Department of Mechanical Engineering. A group program on fluid mechanics, thermodynamics, and heat transfer is directed toward fundamental experimental and theoretical studies in free molecular flow taking place in rarefied gases, the special problems of excitation of the atmosphere surrounding a body entering a planetary atmosphere at high velocity and the heat transfer problems associated with reentry, and the general considerations of magneto-

hydrodynamics.

Studies are being conducted on detonation processes associated with various types of fuels and shock waves in gases and their bearing on propulsion; special attention is being paid to reaction kinetics. Two of the grants of this part of the program are administered by the Institute of Engineering Research of the College of Engineering.

The project on kilovolt-ion sputtering has a twofold interest with respect to space technology, one the degradation of materials in space, the other the ion propulsion engine. The studies combine solid state physics and the physics of plasmas and rarefied gases.

NSF GP-2103; NSF GP-2520; NAS 8-2634;  
NsG 702; NsG 10-59; AF 129-63; NAS 3-5743

The foregoing brief review is given to show the relationships between the many components of the program and how the work fits into an academic structure of faculty-student research.

Samuel Silver  
Director

# PERSONNEL

## ADVISORY COMMITTEE

Prof. K. Anderson	<u>Ex Officio Members</u>
Prof. C. W. Churchman	Dean R. Connick
Prof. H. Jones	Dean J. Cowee
Prof. N. Pace	Dean S. Elberg
Prof. M. Protter	Dean W. Fretter
Prof. K. Watson	Dean G. Maslach
Prof. H. Weaver	
Prof. M. Calvin, Chairman	

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Anderson, Prof. K.	Jones, Prof. H.	Smith, Prof. H.
Berger, Prof. Stanley A.	Jukes, Prof. T.	Spinrad, Prof. H.
Blankenship, Prof. L. (on leave)	Krech, Prof. D.	Starkman, Prof. E.
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Holt, Prof. M.	Silver, Prof. S.	Zadeh, Prof. L.
Hurlbut, Prof. F.	(research leave to June 31, 1964)	Pigford, Prof. T.

## NON-FACULTY PROFESSIONAL RESEARCH

Cooper, Elizabeth	Lord, R. G.	Rea, Donald G.
Eglinton, G.	Mackay, R. S.	Scher, Stanley
Fiala, Jiri	Mandeles, Stanley	Schubert, G.
Gee, Henry K.	Meyer, Joachim	Strickland, Donald
Krakow, Joseph S.	Moulic, E. S.	Thornton, Douglas
Laderman, A. J.	Palm, Ann	Urtiew, Paul
Lee, Samuel S. C.	Raacke, I. D.	Wilcox, John

## ENGINEERS

Fishman, Harvey	Jenkinson, Frederick	Nicholson, David (student)
Griffith, Paul	Jurgens, Andrejs (student)	Paoli, Richard
Jacobsen, Robert (student)	Keachie, Stephen	Sabanias, Mitchell
Jakus, Karl (student)	Leon, Alberto	Talbert, John W.

## POST GRADUATE SERIES (Not Students)

Krotkov, Mary



## GRADUATE STUDENTS

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Belsky, Theodore  
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Castro, Barry  
Caton, William  
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Kumar, Rosetta  
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Zelwer, Ruben

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Roberts, S. R.  
Salkin, Max

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Gillespie, Arch  
Harris, Frank  
Holmes, Lynn

Hom, Kenneth  
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Scholz, Roland  
Senn, Martin C.  
Steffen, Robert  
Tsia, Robert H.  
Walsh, John  
White, Gary

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Tanaka, Terry (student)

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Giba, Wiadyslaw  
Laurie, Raymond  
Petersen, Harry

Thompson, Kenneth L.  
Van De Venter, Joseph  
Woods, Ernest  
Wuth, Clarence R.

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Broadhead, Frank (student)  
Brown, Robert (student)  
Cipolla, Victoria (student)  
Duffey, Paul  
Galliano, Warren  
Jensen, David (student)  
Kamino, Mariko

Marion, Rodger  
Riggin, Alfred (student)  
Shahan, Elma  
Steel, Gerald (student)  
Wells, Ronald (student)  
Zaklad, Halm (student)

### ANIMAL TECHNICIAN

Heuschober, Howard

### ANIMAL CARETAKERS

Frazier, Roscoe  
Sadler, Charles (50%)

### PROGRAMMER

Simon, Frances

### SPECTROSCOPISTS

Olsen, Richard  
Walls, Fred

### STOREKEEPERS

Sadler, Charles (50%)  
Sturke, William

PROJECT TITLES AND INVESTIGATORS  
AND CONTRACT/GRANT IDENTIFICATION

<u>Faculty Investigator</u> <u>(Project Director)</u>		<u>Sponsor and</u> <u>Contract/Grant No.</u>
Profs. S. Silver and J. Welch	"Solar Radiation and Atmospheric Absorption in the MM Wave Region"	ONR Contract Nonr 222(54)
Prof. S. Silver Profs. C. W. Churchman and L. Preston (Social Studies)	"General Support"	NASA Grant NsG 243-62
Prof. S. Silver	"Facilities"	NASA Grant NsG(F)-5
Prof. S. Silver (Dr. S. Scher)	"Biochemical Activities of Terrestrial Microorganisms in Simulated Planetary Environments"	NASA Grant NsG 126-61
Prof. K. Anderson	"Preparation of Flight Hardware for the First Interplanetary Monitor Satellite"	NASA Contract NAS 5-2989
Prof. K. Anderson	"Preparation of Flight Hardware for the First Orbiting Geophysical Observatory"	NASA Contract NAS 5-2222
Prof. K. Anderson	"Electron Precipitation into the Auroral Zone"	NSF Grant NSF GP-2252
Profs. M. Calvin and S. Silver (Dr. D. G. Rea)	"Development of Scanning System for the Mariner Spacecraft"	NASA Contract NASr-220
Profs. M. Calvin and H. Weaver (Dr. D. G. Rea)	"Reflection Spectra as a Basis for Studying Extraterrestrial Life"	NASA Grant NsG 101-61
Prof. H. Jones (Prof. T. Jukes)	"Chemistry of Living Systems"	NASA Grant NsG 479
Prof. H. Jones (Prof. T. Jukes)	"Space Physiology"	NASA Grant NsG 600
Profs. D. Krech and M. Rosenzweig	"Effects of Varied Degrees of Sensory Deprivation on Brain Chemistry, Brain Anatomy and Behavior"	NASA Grant NsG 154-61

PROJECT TITLES AND INVESTIGATORS (Cont.)

<u>Faculty Investigator (Project Director)</u>	<u>Project Title</u>	<u>Sponsor and Contract/Grant No.</u>
Prof. H. Mark	"Theoretical and Experimental Evaluation of Inelastic Neutron Scattering and Other Neutron Induced Reactions for Remote Surface Analysis"	NASA Grant NsG 452
Profs. G. Maslach R. Seban, S. Schaaf	"Fluid Mechanics, Thermodynamics and Heat Transfer:	NSF Grant NSF GP-2103, NSF GP-2520
Prof. A. Oppenheim	"Detonation Studies of Mixtures Gaseous Hydrogen and Gaseous Oxygen"	NASA Contract NAS 8-2634
Prof. A. Oppenheim	"Gas-Wave Dynamic Studies of Spray Combustion"	NASA Grant NsG 702
Prof. A. Oppenheim	"Reaction Kinetics of Accelerating Flames"	NASA Grant NsG 10-59 (IER)
Prof. A. Oppenheim	"Development and Stabilization of Detonation"	AFOSR Grant AF 129-63 (IER)
Prof. W. Oswald	"Detection and Study of Microorganisms in the Upper Atmosphere"	NASA Grant NsG 104-61
Profs. H. Smith and F. Hurlbut	"Investigation of Kilovolt Ion Sputtering"	NASA Contract NAS 3-5743
Prof. S. Ward	"Contributions to Surface Magnetic Fields from Sources Internal and External to the Earth"	ONR Contract Nonr 222(89)
Prof. S. Ward	"Secular Change and Origin of the Dipole Field"	CGS Grant CGS 1167(G)
Profs. S. Ward and S. Silver	"Effect of the Ionosphere on Attenuation of 'Pearl' Activity"	NSF Grant NSF GP-1775
Prof. H. Weaver	"Infrared Planetary Observatory in the Stratosphere"	NASA Grant NsG 255-62
Prof. T. Pigford	"Surface Ionization and Electron Emission from Refractory Metals"	A. E. C. and University funds
Prof. T. Pigford	"Interaction of Alpha Particles with Semiconductors"	A. E. C. and University funds

TECHNICAL REPORTS AND PAPERS IN THIS PERIOD

NsG 243-62

"The Propagation of Electromagnetic Waves in a Statistically Inhomogeneous Medium. I: A Critique of the Current Theory", S. Silver. Series 5, Issue 29.

Nonr 222(54)

"On the use of Rutile as an 8 mm Maser Material", Toshio Hori. Series 5, Issue 39.

"The Propagation of Electromagnetic Waves in a Statistically Inhomogeneous Medium. I: A Critique of the Current Theory", S. Silver. Series 5, Issue 29.

NsG 600

"Deep Body Temperature of Untethered Dolphin Recorded by Ingested Radio Transmitter", R. Stuart Mackay, Science May 15, 1964, Vol. 144, No. 1620, pp. 864-866.

NsG 101-61

"Hydrocarbons of Biological Origin from a One-Billion Year Old Sediment", G. Eglinton, P. M. Scott, T. Belsky, A. L. Burlingame and M. Calvin, Science in press.

## "SOLAR RADIATION AND ATMOSPHERIC ABSORPTION IN THE MM WAVE REGION"

ONR Contract  
Nonr 222(54)

### Installation of the 10-foot Telescope at Hat Creek

The main effort during the past quarter has been the installation of the 10-foot antenna with its new mount at the Hat Creek Observatory. During the first week in June the antenna was removed from the roof of Cory Hall and taken by truck with the new mount to the Observatory. The mount was placed on the pad and the antenna on the mount. To test the rigidity of the mount and also to find the proper location of its polar axis, a star track of Polaris was photographed. A smooth circular arc was obtained when the mount was slewed in hour angle showing the structure to be satisfactory. An error of 5 minutes of arc in the alignment of the polar axis was noted from the photograph. This will be corrected by appropriate shims under the feet of the mount.

The electronics for indicating the position of the mount are currently being built but will not be ready for some weeks. In the meantime tracking will be accomplished by means of a 24 power sighting telescope. The mount can be slewed from horizon to horizon in about 5 minutes and operated at any speed slower than that down to about half the sidereal rate.

### Instrumentation for Observation of Venus

Inferior conjunction of Venus is very favorable this year, occurring as it does, on June 19. The first project to be performed with the new installation is the observation of Venus while it is near the Earth. For this purpose, a radiometer which can be tuned over the range of frequencies from 18 Gc to

40 Gc has been developed and is being installed on the antenna. The receiver has two separate RF sections, one covering K-band (18 - 26.5 Gc) and one covering  $K_a$ -band (26.5 - 40.0 Gc). Some difficulty has been experienced due to the wide tuning range, but this has been accomplished with only a small loss in sensitivity (about 10 percent on the average) over what is possible with a fixed frequency radiometer.

The goal of these observations is to better define the variation in equivalent black body temperature of Venus near  $\lambda = 1$  cm. In particular, the existence of water vapor in the lower atmosphere of Venus may appear as an absorption feature in the planet's emission spectrum. The presence of other gases (such as  $SO_2$ ) may also be detected by this measurement.

#### Instrumentation for Ozone Studies

Before the 10-foot antenna was removed from Cory Hall, an attempt was made to observe the atmospheric ozone absorption at 36 Gc using the two frequency switching radiometer described in the previous report. The results were inconclusive, primarily because of the difficulty in maintaining the same receiver gain at the two frequencies. As the zenith distance of the Sun increases and the intensity of its radiation accordingly decreases, a virtual output from the radiometer develops due to the difference in receiver gain at the two frequencies. This appeared to be due to klystron instabilities and it was decided to use the voltage tunable  $K_a$ -band BWO instead and switch its frequency. It was also decided to add a third frequency. Further measurements will be made at Hat Creek in the late summer following the observation of Venus.

#### Submillimeter and Infrared Work

The work on the mobile laboratory for submillimeter and infrared studies

discussed in the previous quarterly report (May 1, 1964) is still in progress. There is nothing of real technical significance to report at this time. We hope to be in the field to make our first observations in September.

### 8 mm Maser Development

The design for the 8 mm maser called for a single crystal of iron-doped rutile of dimension .4 x .4 x 25 mm. After many trials this proved impossible to fabricate. The design must be abandoned.

Three alternatives can be suggested for future work in 8 mm masers.

(1) Use of iron-doped rutile in a reflection-cavity type amplifier. Here again the size of the required crystal causes difficulties. A single-mode cavity is not possible. If a multi-mode cavity is used, we must be sure that ample gain is available while at the same time no mode can oscillate. Since simultaneously adjusting the Q of each mode is not possible, the suppression of oscillation is best insured by allowing only one cavity resonance frequency within the bandwidth of the material. Using a value of 50 mc for the material bandwidth, the modes should be spaced at least 100 mc apart. The determination of cavity modes in a rutile cavity is not possible at present because of the anisotropic dielectric constant of rutile. However, a successful maser could probably be constructed experimentally.

(2) The use of chromium-doped beryl (emerald) is known to have energy levels suitable for mm wave maser construction. However, commercially available beryl is of poor quality with much twinning and a material bandwidth approaching 1 Gc. However, it does have the advantage of a reasonable dielectric constant. If beryl of good quality can be obtained or grown a beryl maser is a good possibility.

(3) Use of some new material might be considered. Our current difficulties show that rutile is not the most desirable material. A previous



review of possible crystals showed that lanthana and zircon were among the interesting materials which should be investigated. Zircon has a very high probability of successful synthesis and warrants investigation as an 8 mm base material (it might also be a good host for lasers).

GENERAL SUPPORT GRANT

"INTERDISCIPLINARY RESEARCH IN THE PHYSICAL,  
BIOLOGICAL, ENGINEERING AND SOCIAL SCIENCES"

NASA Grant  
NsG 243-62

PHYSICAL AND ENGINEERING SCIENCE PROJECTS

1. Plasma Physics

Dr. E. A. Cooper has continued to work on the propagation of magneto-hydrodynamic waves in wave guides. Particular attention has been given to the boundary conditions between a plasma and a vacuum or a neutral gas, since these conditions determine the form of the propagating modes. A report is being prepared on this problem.

Mr. Richard Miller is at present investigating the effects of electron streams flowing in the upper ionosphere and magnetosphere. Other investigators have recently claimed that instabilities resulting from such streams are possible explanations of irregular magnetic pulsations (Nishida, JGR 69, 947 (1964)) and induced whistler emissions (Bell and Buneman, P. R. 133, A1300 (1964)). The work of these investigators has been shown to be in error and a report is in progress which will summarize the effects of such electron streams.

2. Lunar Studies

Work is being continued on the stream of solar plasma past the Moon. Further study of an earlier method involving an Oseen-type equation has been found unsuitable after values appropriate to our system for the ratio of the undisturbed flow velocity to the Alfvén velocity, squared,  $m = \frac{v^2}{H^2/4\pi\rho}$ , and for the magnetic Reynold's number,  $R_m = \mu \sigma \ell v$ , had been evaluated. Another approach of linearizing the equation of motion is now being used as a starting point. Stewartson's theory (Z. angew. Math. Physik 12, 261, 1961) of two-dimensional flow past a thin body is applied. To illustrate the flow pattern in the presence of an oblique field, the solutions for the perturbed velocity and field quantities are being integrated numerically.

This method is being extended to account for a body whose permeability differs from that of the plasma stream and for a slightly conducting and magnetized body. Variations of the properties of the plasma can be incorporated in the same model.

3. Martian Blue Clearing (Dr. A. Palm and Mr. B. Basu)

In view of well known interactions of the solar wind with comets and planetary atmospheres, the possibility of a correlation of the Martian blue clearing and solar flares is being explored. Data of both events observed during the past 12 years are being collated and plotted. Depending upon the results of this work, a statistical analysis will be performed.

4. Planetary Spectroscopy

Prof. H. Spinrad has found a large number of new weak absorption lines in the near infrared spectrum of Venus around  $\lambda$  8750. The spacing of these weak features is such as to suggest they are to be identified with a carbon dioxide band whose lower level is approximately 667 wave numbers above the ground state. If the identification of these features with a CO<sub>2</sub> hot band is correct, the distortion of these lines implies a temperature of approximately 400° C in the visible Venus atmosphere.

5. Hydromagnetics of the Magnetosphere

Radiation from ionospheric and exospheric current sources is being studied by D. P. O'Brien with a view toward explaining certain features of natural micropulsation fields. Energy distribution between the familiar ordinary and extraordinary modes from these sources is strongly dependent upon the tensor conductivity entries. Our analysis at this point is restricted to local current sources in the ionosphere (near field phenomena) and the effect of a finite conductive earth on these natural fields. As an

example of a possible local source, we have considered the problem of an infinite line source parallel to the magnetic field in an infinite anisotropic ionosphere. The field quantities  $E_z$  and  $H_\theta$  are given exactly by:

$$\begin{aligned} E_z &= I \omega \mu_0 e^{i\pi/2} K_0 \left( e^{i\pi/2} \sqrt{\epsilon_{\parallel}} \frac{\omega r}{c_0} \right) \\ H_\theta &= \frac{I \omega}{c_0} \sqrt{\epsilon_{\parallel}} e^{i\pi/2} K_1 \left( e^{i\pi/2} \sqrt{\epsilon_{\parallel}} \frac{\omega r}{c_0} \right) \end{aligned}$$

where  $\hat{z}$  is the direction of the static magnetic field  $B_0 \hat{z}$ ,  $\hat{\theta}$  is the direction tangent to the radius vector  $\hat{r}$ , which is perpendicular to  $B_0 \hat{z}$ , and  $K_0(x)$  and  $K_1(x)$  are modified Bessel functions of the zeroth and first order. The fields in this case are analogous to those propagating in a conductor. Note also that only the ordinary mode is excited for this particular source.

## SOCIAL STUDIES PROGRAM

During the last quarter, Professor John T. Wheeler has been Acting Director of the Social Science Group during Professor Churchman's absence. Work on the project has proceeded as follows:

### 1. Research on Research Management Around The World

In the interests of expanding the understanding of the research and development process and its management, C. West Churchman has interviewed a number of persons around the world who have been concerned with various aspects of this problem. In Japan he talked with Dr. Masao Sugimoto who until recently has been in charge of the planning function for Research and Development for the Japanese government. Two recent reports of Japanese activities on research and development planning were obtained and are being translated.

In India Churchman presented a paper on research and development planning to the Council of Scientific and Industrial Research and discussed at some length problems of research and development management with Dr. A. Rahman, who has been assigned the responsibility for R & D planning in India.

At the University of Vienna, in the new Institute for Higher Studies in the Social Sciences, Churchman presented eight lectures on the problems and philosophy of research management.

In West Germany he spent a week with the Studiengruppe für Systemforschung reviewing their projects. This is a new research group which has been set up in Heidelberg to study problems of the relationship of science to society and politics, with a strong emphasis on concepts of systems science and system development. One of their projects which deals with information retrieval in the chemical literature bears a marked resemblance to the project on the design of inquiring systems which has been discussed in earlier progress reports. The chemical project attempts to use "analogous hints" to guide the chemist to prepare sources in the literature for new ideas. The design of inquiring system work is also trying to develop a theory of analogy in the search for ideas, essentially using computer technology. It is therefore planned to coordinate the West German work with the effort of Berkeley. Dr. Helmut Krauch of the Studiengruppe für Systemforschung will visit the United States in the fall of this year and will come to Berkeley for some period of this visit.

Dr. Horst Rittel, also of the Studiengruppe, is a lecturer on the Berkeley Campus for 1964-65. He has been working on the theory of innovation and an attempt will be made to work out a cooperative arrangement with him so that he can spend part of his time with the Social Science Project.

In June a conference was held in West Berlin on Forschung, Staat und Gesellschaft, in which the relationship of science to politics was discussed: scientific policy formation, the role of the scientist as an expert in the political

arena, the social impact of science, etc. Churchman was speaker and chairman of part of this conference. The proceedings will be published some time during next year.

Discussions also took place in France and the United Kingdom, but as yet it does not seem possible to establish research contacts in these countries until more is known about their plans.

## 2. Inquiring Systems and Research Management

Meanwhile, work on the design of inquiring systems is continuing in the form of a monograph; the work on the preparation of the test of research management using the production analogy is also in preparation.

## 3. The Role of the Research Director

An interview schedule for research directors has been prepared. It is planned to test the questionnaire at the Naval Ordnance Test Station, China Lake, California, at the end of July.

To review the purposes of this study, they are two-fold: The interest of Churchman and the other of Kruytbosh as follows:

a) Churchman's interest in the study stems from his concern with "inquiring systems" and the general process of research as a decision-making process (cf. chapters 1 and 14 of his Prediction and Optimal Decision). He wants to obtain preliminary materials for an operations research study of the relative emphasis given by research and development administrators to the "outgoing", "administrative" and "personal support" aspects of their work.

By outgoing he means interest in corporate or agency policies and politics, interest in marketing the research or development output, securing additional funds, and concern for the image of his organization. By administrative aspects he refers to attention to budgeting, hiring and firing of personnel. By supporting research personnel he means attention to motivation,

providing adequate facilities, documents, and interchange of ideas, and assisting in the formulation of problems and research procedures.

b) Kruytbosch's interest in the study is sociological, stemming from a concern with patterns of authority and coordination in large organizations. Considerable work is currently being done on the psychological and social correlates of creativity and productivity in scientific research and development. Some workers argue that "research is the people" and that if you have good men, supervision is unnecessary, even undesirable. Other studies indicate that "styles of supervision" are indeed related to performance in the laboratory -- with variations along the basic research -- development project continuum. However, the only measures of styles of supervision that have been worked out so far are judgements by the "bench" workers of their superiors.

Kruiytbosch is approaching the problems of styles of supervision from the inside, so to speak. He is developing measures of task content, conceptions about (attitudes toward) the proper role of the R & D administrator, and patterns of interaction with superiors, subordinates and others. He hopes to show how various combinations of these variables -- the styles -- represent adaptations to the existing organizational constraints.

#### 4. Capital Budgeting Process

In the last quarter Professor John Wheeler's project has proceeded on schedule although it has been revised in certain respects due to the lack of availability of certain data. The changes made necessary by this turn of events will lengthen the project to some extent.

Most of the work in the last three months has centered around the completion of the first round of interviews. In addition to the continuation of interviews at Ames Research Center and at two industrial firms, extensive

interviews were carried out both at NASA Headquarters and at Lewis Research Center. On the basis of the interviews at two centers and at headquarters a rough draft of a paper on budgeting of research and development in NASA has been prepared. The purpose of this paper is to provide a basis for checking on the findings of the interviews, to discover areas where further interviews need to be made, and to verify facts obtained in earlier interviews.

The next quarter should see a completion of the writing of the first draft of the monograph and of most, if not all, of the second round of interviews. Further work will be delayed until the FY66 budget is processed so analysis can be completed on this.

5. Budgeting Behavior in NASA

Preliminary interviewing has been completed by David Conrath for his study on the factors that determine the allocation of NASA's budget. A brief follow-up study will be conducted at Lewis, Ames, Headquarters and perhaps Goddard this coming September. By that time, the first half of his monograph on budgeting behavior should be in rough draft form, and chapters on the research and development process and budgeting are already in their early stages. At present Conrath is formulating his R & D budgeting behavior model, which is structured around decision-making under uncertainty; and he is also reviewing the literature on organization theory in general.

6. Communication and Retrieval of Information

Professor Merrill Flood, assisted by Leonard Jacobson and Alberto Leon, has continued on the test of SASIDS -- a stochastic adaptive information dissemination system for selective distribution of technical abstracts. Some 25 participants have contributed over 200 abstracts, so the 3800 responses by recipients of selectively distributed items have been used in the IBM 7090 to up-date the pair of transmission probabilities connecting each pair of participants.



Much more activity is needed before any evaluation can be made of the System, and it is planned to stimulate this by encouraging use in the future of abstracts taken by the participants from standard abstracting sources.

Professor Flood and Mr. Leon have completed preliminary test runs of GROPE, a self-adaptive search code for numerical analysis, using a group of four subprograms: LOOK, SATTER, SHRINK, and RANDOM. Each subprogram is independently adequate to solve each test problem, but GROPE uses a mixture of the four with each selected probabilistically at each stage of the solution of any one problem. Small linear programming problems (10 x 16) have been used in the test runs, and LOOK has won out as the subprogram most frequently used. Other subprograms are being added and GROPE will be tested also on other classes of problems. The IBM 7090 FORTRAN IV code is described in Internal Working Paper No. 11, "Steps Toward a Universal Adaptive Code for Optimization (GROPE)", by Alberto Leon, April 1964.

7. Relationship Between Headquarters and Centers

Professor L. V. Blankenship is continuing the analysis of interviews completed to date at the Ames Research Center and will finish this phase of the study of field-center-headquarters relationships shortly. Some of this material is being used in the construction of a questionnaire which will be used on a more systematic basis to collect information from field center and headquarters officials on this subject. Working on a different phase of this study, Barry Silverman is completing his study of the first two years of NASA operations, based mainly on Congressional hearings, and is writing up his findings.

8. Performance Study

Research is continuing on technological progressiveness of aerospace

firms. A model is being developed and data are being gathered by Professor Herman Stekler.

9. Corporate Goals

Herschel Kanter will soon complete a study, Research and the Organization: A Decision-Making Approach, which attempts to explain why organizations undertake research and how they choose and control their research programs. (A more complete description appears in the last Quarterly Report). Part of this study appeared as Research and the Organization, Internal Working Paper No. 12. This paper describes the interaction of the research community and formal organizations in the development of a research program.

10. Spatial Distribution of R and D and Economic Relationships

Progress has been greatly help up on this study because of inaccessibility of relevant data. Lawrence Nordell has also begun preliminary work for Professor Radner on a study of the economics of education, in particular, an activity analysis model of the California education system.

11. Analysis of Decision-Making in an Industrial D. O. D. Program

The second part of a two-part working paper on the aerospace industry, emphasizing the importance of contractual arrangements with respect to such economic variables as efficiency, optimality, and degree of completion has been completed by Douglas Woodfill.

12. Institutional Firms

Gerald Swatez is continuing research for his doctoral dissertation on the interaction between Scientific Norms and Organizational Requirements in a University Laboratory. He will present a paper with that title at the American Sociological Association in Montreal, Canada, in September.

The paper describes the organization of a large University-affiliated research laboratory and sets forth certain connections between the roles played by incumbents of statuses within research groups and norms of the scientific community. That part of the research process that consists of transactions between members of the research group is provisionally analysed in terms of norms of independence, reciprocity, and legitimacy, and in terms of the basic institutional processes of recruitment, socialization, and social control. The actual relationships holding within the organization are shown to result from both the norms of science and the requirements of the organization. Conflict between organizational requirements and scientific norms, and the accommodations that resolve these conflicts, are explored.

13. Political and Sociological Study -- Responses to the Space Age

A paper entitled, "Preliminary Thoughts on the Politics of Closed Environments," which will include the design for an empirical study in that area is being prepared by Dr. Donald Strickland.

He is also contemplating studies of the negotiation of bilateral, multi-lateral, and international space cooperation agreements, as described in the last Quarterly Report. Preliminary plans are being made for a study of inter-governmental relations at a major NASA site, with attention to the classic problems of public administration from among State, county, municipal and Federal agencies.

Research in the general area of the politics and sociology of science will be undertaken, instructed by Dr. Strickland's visit to NASA Headquarters this summer.

14. Incentives for Graduate Research

A study of the incentives which induce graduate students to undertake commitments to particular research specializations is being continued by Barry Castro. He is especially interested in those incentives which can be manipulated by graduate schools and agencies responsible for the stipend support of graduate students. His hypotheses can be divided into two basic parts: (1) that there is an increasing tendency for commitment to particular research specialties to take place early in the graduate career; (2) that graduate students generally "choose" research specialties in response to short-term contingencies (e. g. differential availability of stipend support and differential access to equipment) rather than relatively long-term contingencies (e. g. differences in the anticipated research fertility or in the anticipated flexibility of job choices associated with the various fields open to them). A number of more specific hypotheses drawn from decision-making theory and analyses of investment in human capital will be considered. Exploratory interviews with graduate students in the natural sciences are planned at the University of California this summer.

"FACILITIES"

NASA Grant  
NsG(F)-5

The construction contract for the Space Sciences Laboratory Building was awarded to F. P. Lathrop Company. The construction contract was recorded and work started on April 27, 1964.

During May site clearing, excavation grading, dirt hauling, and stock piling back fill material was completed and drilling for piles was started.

Drilling was suspended in mid-June because the drilling equipment was inadequate. On June 29 the contractor obtained heavier equipment and drilling continued.

In July drilling for piles continued and concrete piles were poured.

DEVELOPMENT OF SCANNING SYSTEM  
FOR THE MARINER SPACECRAFT

NASA Contract  
NASr 220

In initiating this program RFP's were sent to over twenty companies soliciting bids for the construction of the engineering breadboard of the Mars Scanner. On the basis of both technical and financial considerations the proposal of the Te Company was accepted. The design of the instrument has been finished and all of the components have been ordered.

In conjunction with the experimental program we are calculating the expected absorption and emission spectrum of the Martian atmosphere in the spectral regions which we are studying. We are also carrying out a literature survey of all reported sightings of white and of yellow clouds on Mars. The repeated occurrence of white clouds over specific areographic sites could be the result of emission of water vapor from the sites. Since this in turn would suggest the presence of fumaroles or of similar activity both in the category of micro-environments more hospitable to a Martian biota than the general surroundings, these areas would be prime objectives for study with the Scanner.

We are also setting up a computer program for calculating the scattering function of small particles of hydrated ferric oxides. Initially we will use a computational scheme derived by Deirmendjian and Clasen of the Rand Corporation together with literature data on the refractive index and absorption coefficient of the solids.

## BIOCHEMICAL ACTIVITIES OF TERRESTRIAL MICROORGANISMS IN SIMULATED PLANETARY ENVIRONMENTS

NASA Grant  
NsG 126-61 (S-1)

The current research program represents an extension of previous investigations which consider the absence of atmospheric oxygen as a potential constraint upon biochemical activities of terrestrial organisms. The principal approach to these problems has been microbiological. The studies reported here relate to biological problems posed by anaerobic environments of the terrestrial planets, the biological contamination problems, and associated problems of planetary biology.

In previous reports we have proposed that photochemically generated oxidants may satisfy the requirement for molecular oxygen as electron acceptor for oxidative reactions on planets such as Mars where atmospheric oxygen is below the level of detectability. Recent studies on the nature of the oxidant needed for oxidative syntheses which are closely coupled to the photochemical apparatus of anaerobic bacteria, provides additional support for the proposal that photooxidative reactions constitute a primary mechanism by which such microorganisms can perform biochemical transformations that are normally linked to atmospheric oxygen in terrestrial aerobes. From studies on analogous systems, it is apparent that the initial reaction in the generation of photochemical oxidants represents an electron transfer step which is independent of temperature. Such a temperature-insensitive photooxidative process may provide a mechanism for the production of high potential electron acceptors on planets having low surface temperatures.

An invited paper entitled "Planetary Photobiology: Prospects and

Problems" is being prepared for presentation at the forthcoming Symposium on Photochemistry and Photobiology in Space Research in Oxford, England. The paper is largely concerned with problems of biochemical evolution in planetary environments lacking atmospheric oxygen, and calls attention to photochemical oxidation mechanisms as offering a partial solution to such problems.

A paper on "Biological Contamination, Back Contamination and Pan-spermia" is being prepared for publication in a contributed volume derived from a recently completed University of California statewide lecture series on the theme "Horizons in Space Biosciences: Exobiology". This paper is concerned with problems of biological contamination during early lunar and planetary exploration, the possibility that extraterrestrial life carried by returning spacecraft may present a hazard to life on Earth, and also discusses current views on the Arrhenius Hypothesis.

Mr. Daniel J. Simon, a NASA fellow from Dr. Vishniac's group in the Department of Biology and Space Science Center of the University of Rochester, is currently visiting our laboratory as a guest investigator. He has initiated experiments to study the ultraviolet sensitive genetic determinants which confer photosynthetic activity upon plastids. His visit to Space Sciences Laboratory reciprocates Dr. Scher's short stay with Dr. Vishniac's group preceeding the Rochester Space Biology Workshop.




"PREPARATION OF FLIGHT HARDWARE FOR THE  
FIRST INTERPLANETARY MONITOR SATELLITE"

NASA Contract  
NAS 5-2989

A wealth of new and interesting data continued to flow into the laboratory from the University of California experiment on the Explorer 18 satellite launched last November 26 until a few weeks ago when one of the main satellite systems malfunctioned. It is likely that after about six months of operation its useful life has ended. There is a possibility it will again send useful data in a few months when it begins to receive more power from its solar cells.

Analysis of the results from this first University of California satellite experiment are well underway.


Also, preparations for the second IMP satellite are well along. This satellite will be launched this fall again carrying a University of California, Berkeley, experiment.



"PREPARATION OF FLIGHT HARDWARE FOR THE  
FIRST ORBITING GEOPHYSICAL OBSERVATORY"

NASA Contract  
NAS 5-2222

Integration of experiments into the spacecraft has been completed at Space Technology Laboratories and the spacecraft has been shipped to the Atlantic Missile Range. Final tests begin there in July and it is hoped that this major satellite will be in orbit before the end of this year. The University of California Berkeley solar cosmic ray experiment continues to operate satisfactorily. The purpose of this experiment is to study the few, but important, low energy solar cosmic ray events expected during solar minimum.



"ELECTRON PRECIPITATION INTO THE AURORAL ZONE"

NSF Grant  
NSF GP-2252

The purpose of this new grant is to support development of new experimental apparatus to be flown on high-altitude balloons in 1964 as part of the International Quiet Sun Year program. The purpose of the experiment is to obtain further information on the precipitation of high energy particles into the Earth's atmosphere in the auroral zone. These particles were members of the population of particles in the Van Allen Radiation Zone until some dynamic process caused them to be dumped down the Earth's magnetic field lines into the atmosphere. The primary scientific purpose of the investigation is the understanding of the origin of the Earth's Radiation Zone. An important feature of the study is correlation of results with satellites making direct measurements on the particles in the Radiation Zone.

Prototype design has been completed and construction of electronic circuits for the flight units has begun.

"REFLECTION SPECTRA AS A BASIS FOR  
STUDYING EXTRATERRESTRIAL LIFE"

NASA Grant  
NsG 101-61

Optical Spectroscopy

In the work on our Michelson interferometer the installation of the reference interferometer, to be used in producing reference fringes which will monitor the travelling trihedral, has been completed. Interferograms have been recorded for the  $3.39 \mu$  line of a He-Ne gas laser and have been reduced in the computer. Although the spectrum is noisier than should be the case it is vastly improved over that derived without the use of the reference fringes. The testing is continuing and is being accompanied by a computer program to determine the effects of noise in the laser output and in the reference fringe position on the spectrum.

The radar return of 68 cm microwaves from the Moon as recorded by the workers at Millstone have been analyzed using a simple model which assumes only that the majority of the reflection can be described by geometric optics. The preferred values for the lunar surface dielectric constant and rms slope are 2.6 and  $13^\circ$  respectively. Our approach is a novel one to this particular problem and we believe it provides new insight into the microwave scattering problem. The formulae can readily be extended to the calculation of emissivities, a program which we will initiate during the fall term.

A chapter for a forthcoming book on exobiology entitled "The Evidence for Life on Mars: Nature and Uncertainties" has been written and submitted to the book's editor. This is a general review of the problem but it also incorporates some new ideas.

## Analysis of Organic Matter in Meteorites and Ancient Sediments

Procedures have not been developed for the small-scale extraction, separation and analysis of alkane fractions present in biological sources, terrestrial sediments and meteorites. Thus, molecular sieve (5 Å) treatment followed by gas-liquid chromatographic separation and collection, and mass spectrometric identifications (modified Consolidated CEC 21-103C) at the microgram level confirms the literature findings for tobacco wax that the normal alkanes are mainly, but not exclusively, odd-numbered; and are accompanied by 3-methyl (principally even-numbered) and 2-methyl (principally odd-numbered) substituted n-alkanes. A similar procedure has revealed the preservation of a 'biological' distribution pattern in both the normal and branched alkane fractions of an Eocene shale (ca  $60 \times 10^6$  years), and identification of a number of the latter compounds by mass spectrometry is presently under way.

We have extended this approach to an extremely ancient crude oil which seeps in small quantities from the Precambrian Nonesuch Shale at the White Pine Mine in Michigan. Recently we have isolated the diterpene hydrocarbon, phytane (2,6,10,14-tetramethylhexadecane), and the nor-diterpene, pristane (2,6,10,14-tetramethylpentadecane), from the branched fraction\*. Although we have yet to isolate and identify these two hydrocarbons in the shale thought to be the source bed, we have found closely similar gas chromatographic patterns for the oil extracted from it. The shale is Keewenawan (ca  $1 \times 10^9$  yrs) and geologic opinion favors the viewpoint that the organic matter in the rock was deposited with the original sediment.

We feel that the isolation and identification of these hydrocarbons, which must surely be biogenic in origin, augurs well for the extension of this life-detection approach to the older Precambrian formations. Furthermore, the

\* This work is described in a note which has been submitted to Science for publication.

survival pattern of organic compounds over long periods of time under terrestrial conditions should also provide templates for an understanding of the meteorite record.

### High Resolution Mass Spectrometry

In this laboratory, the Mattauch-Herzog geometry is employed in the C. E. C. 21-110 double-focusing mass spectrometer/spectrograph. Studies in progress in our laboratory center around two basic problems: (a) the capability of accurate mass measurement of many ions in a single mass spectrum; and the related problem (b) the capability of obtaining as much mass spectral data as possible on extremely small amounts of sample. Therefore, the simultaneous, permanent registration of an entire mass spectrum on a photoplate at highest attainable resolution consistent with unique characterization of empirical composition is of utmost importance in our studies. The combination photoplate, ion multiplier employed in the Mattauch-Herzog configuration, allows such versatility.

### Current Results:

#### I. Experimental Techniques

A direct sample inlet system for introduction of (a) solids of low volatility and (b) thermally labile compounds has been constructed in our laboratory.

The system is all glass with the exception of the teflon probe and is heated as one unit. The vacuum lock valve will hold  $10^{-7}$  mm Hg in the ion source when exposed to atmospheric pressure. This direct inlet has a ground glass ball joint valve and its own vacuum system. This has the advantage of our being able to pump samples out directly from the direct inlet line without necessitating the complete pump out through the source chamber.

## II. Automatic Data Reduction from Photoplate.

The chief experimental problem involved in high resolution mass spectrography is the reduction of data from the photoplate. In our laboratory, a digitized, high-precision automatic recording microphotometer (Jarrall Ash 23-500) is employed to give simultaneously line position (in microns) and plate blackening (in percent transmission). These data are read out on an IBM card punch during the microphotometer tracing of the high resolution spectrogram. The precision of linear measurement is  $\pm 1$  micron which corresponds to about one millimass unit at normal dispersion on the photoplate up to mass 400. Data for the average deviation of our measurements is in the order of 1.5 millimass units under these conditions. The accurate mass is calculated via a quadratic interpolation using fluorocarbon mass calibration. All accurate mass measurements are carried out automatically. The calculation of accurate masses is carried out on either the IBM 7094 or IBM 7044 computer.

## III. Mass Spectrometry in Molecular Structure Studies

A. High sensitivity-low resolution mass spectral data has characterized several isoprenoid compounds of presumed biological origin isolated from a billion year old sediment<sup>1</sup>. These studies are continuing in the organic geochemistry section.

B. Elucidation of Fragmentation Mechanisms via Determination of the Empirical Composition of All Ions in a High Resolution Mass Spectrogram

A detailed study of the fragmentation mechanisms of Amaryllidaceae and lycopodium alkaloids is in progress<sup>2</sup> in conjunction with an evaluation of the mass spectrometer's performance (sensitivity vs resolution) and the development of a routine system for reduction of the enormous quantity

of accurate mass data.

The empirical compositions of the fragments represented by lines in high resolution mass spectra have provided a detailed knowledge of the fragmentation pathways in these two skeletal systems reported<sup>2</sup>.

The vast quantity of precise information derivable from such an approach to high resolution mass spectrometry cannot be over emphasized.

It is apparent that high resolution mass spectrometry can play a unique role in the unambiguous structural characterization of minute amounts of organic materials encountered in geochemical and cosmochemical research.

References:

1. G. Eglinton, P. Scott, T. Belsky, A. L. Burlingame and M. Calvin, Science, in press.
2. A. L. Burlingame, A. S. T. M. E-14-G. A. M. S. Mass Spectrometry Conference, Paris, September 14-18, 1964.



## CHEMISTRY OF LIVING SYSTEMS

NASA Grant  
NsG 479

### Studies with RNA Polymerase (J. Krakow)

The acid azo dye, Congo red, has been shown to be a very effective inhibitor of the RNA polymerase from A. vinelandii. At a dye concentration of  $1 \times 10^{-6}$  M there is a 70 percent inhibition of RNA synthesis when native calf thymus DNA is used as the template. With the related dye, methyl orange, 100 times more dye is required to obtain this degree of inhibition. By comparison, actinomycin D in this assay at a concentration of  $2 \times 10^{-7}$  M results in a 70 percent inhibition. In contrast with actinomycin D which acts by binding to dGMP residues in DNA, the Congo red acts by binding to the enzyme. This is shown by the fact that polynucleotide synthesis is inhibited by Congo red whether primed by native or denatured DNA, or by poly U, or poly A. Furthermore, when DNA is pretreated with an amount of dye which would give 100 percent inhibition and then the dye is removed by dialysis, priming of RNA synthesis is unimpaired. The high affinity of the dye for RNA polymerase should prove a very useful tool for investigating the active sites on the enzyme.

Further studies have shown that the poly A polymerase found in E. coli ribosomes is also sensitive to Congo red;  $4 \times 10^{-6}$  M dye gives a 75 percent inhibition of AMP incorporation. This concentration of dye, quite surprisingly, results in a slight (30 percent) stimulation of poly U directed polyphenylalanine synthesis in the E. coli ribosome-supernatant system. At  $10^{-4}$  M, 90 percent inhibition of phenylalanine incorporation is obtained. The stimulation of polypeptide synthesis at the lower dye concentration may be causally related to

inhibition of poly A synthesis, since the poly A formed at the ribosome may tend to complex with the poly U and inhibit polyphenylalanine formation.

Investigations on the mechanism of action of polyamines in stimulating RNA polymerase have progressed satisfactorily. When RNA is synthesized by RNA polymerase with native calf thymus DNA in the absence of polyamines, the product is 20 percent retained (at neutral pH) by Millipore filters. When polyamines are included, 80 percent of the RNA is retained. By using  $H^3$  labelled  $T_2$ -DNA as the primer it is possible to show that DNA is also retained. According to Nygaard and Hall (BBRC 12, 98 (1963)) from 10 to 50 percent of native phage DNA is bound by S and S membrane filters (0.4  $\mu$  pore size). The  $H^3$ -DNA used here shows 80 percent retention on S and S filters as well as on Millipore. This is not due to the presence of denatured DNA, this is 100 percent retained by these filters nor is there any effect of polyamines in the absence of RNA synthesis. The high proportion of DNA retained is unfortunate from the standpoint of our work and more will be prepared and filterable DNA will be purified. In keeping with the results earlier shown with calf thymus DNA, RNA synthesized in the presence of spermidine is retained by the filters, and there is almost 100 percent retention of the DNA. This ability to retain the polymerase complex is shown by Millipore filters with pore size of 0.45  $\mu$  and 0.65  $\mu$  and SS membrane filters with pore size of 0.4  $\mu$ .

As mentioned above only a small percentage of the RNA synthesized with calf thymus DNA as primer in the absence of polyamines is retained by the filters, with  $H^3 T_2$  DNA 60 percent of the RNA formed is retained (addition of spermidine after the reaction mix is chilled to  $0^\circ$  results in 90 percent retention; there is no increase with calf thymus DNA directed product.) Heating the complex in the presence of  $N_a$  lauryl sulfate results in no loss of acid precipitable counts but dissociates the RNA from the complex (both with or without polyamines) and renders 90 percent of the RNA and 50 percent of

the DNA filterable.

This is in keeping with the findings of Bremer and Konrad (PNAS 51, 801 (1964)) who showed that the DNA-polymerase-RNA complex demonstrated by sucrose density centrifugation was dissociated by treatment with detergent.

Attempts to study these complexes by this method have not been successful due to poor recovery of  $C^{14}$  RNA. However, our results to date have indicated that the complex formed in presence of spermidine has an appreciably higher sedimentation rate than that formed in its absence. Work is continuing in this area to improve the procedure.

#### RNA Sequence Studies (S. Mandeles)

Purification of  $T_1$  ribonuclease has been completed. Several modifications of existing procedures were necessary in order to remove a contaminating cellulase in crude  $T_1$  preparations. A communication describing these modifications has been submitted to Biochimica et Biophysica Acta.

The investigation of the column chromatography of chemically modified nucleic acid oligomers is continuing. Separations of oligomers with chain lengths up to 6 can now be made with DEAE-Cellulose-7M Urea columns. We are studying the use of DEAE-Sephadex-7M Urea columns for extending the separation to higher oligomers.

#### Enzyme Content of Polysomes (I. D. Raacke, J. Fiala, M. Krotkov)

##### 1) Self-sufficiency of *E. coli* polysome in protein synthesis.

Naturally occurring polysomes of *E. coli*, isolated by a sucrose density gradient, were investigated in respect to their binding with enzymes employed in protein synthesis.

Non-specific adsorption of enzymes to the ribosomes should give a pattern identical with the distribution of total protein in the gradient,

specific adsorption would result in a largely different pattern. The study was therefore concerned with gradient distribution of some enzymes evidently employed in protein synthesis, especially of phosphatases specific for ATP, GTP, CTP and UTP.

All of these phosphatases were found to be concentrated in the polysome fractions, which are generally considered as the active structures in protein synthesis: their distribution is therefore completely different from that of total protein. Heavy fractions display the highest specific activities of enzymes per mg protein, and in the same time contain the largest proportion of the total incorporating activity of the extract.

In assays currently used for the amino acid incorporation, supernatant fraction is usually added to the system; added supernatant contains at least 1 mg of protein per ml of incorporation mixture. In present study, incorporation was performed in the presence or absence of various cofactors. It was found that the function of polysome fractions in complete absence of supernatant resulted in substantial incorporation of radioactive leucine or algal protein hydrolysate. Addition of sRNA caused only moderate increase in incorporation. There was only partial requirement for ATP, but absolute requirement for a triphosphate-generating system.

These results suggest that the polysomes bind triphosphates, some amount of sRNA and all the enzymes necessary for amino acid incorporation. The supernatant stimulates incorporation by polysomes in the absence of added sRNA; after addition of sRNA, the effect of supernatant varies from a small stimulation to a tenfold inhibition of activity. Effect is dependent on the ratio of supernatant protein to ribosomal protein, optimum ratio being about 0.2.

It is therefore evident that polysomes active in amino acid incorporation are optimally saturated with necessary enzymes. The stimulation by

supernatant is possibly due to its sRNA content.

2) XTPases in rabbit reticulocyte ribosomes

To extend our findings about ribosome-bound XTPases in E. coli to the mammalian system, experiments are under way with polysomes prepared from rabbit reticulocytes. Crude extracts and once and twice pelleted ribosomes were prepared according to A. Rich, R. Schweet and M. Takanami, and patterns of ribosomal proteins distribution were studied in gradients under various conditions.

Ribosomal nucleoside triphosphatases were found in one-pelleted ribosomal fractions. Specific activity of ATPase was higher in the polysome region than in the 78 S ribosomal peak.

## SPACE PHYSIOLOGY

NASA Grant  
NsG 600

The concept of a negative impedance was developed. It is to be used for cancelling the unchanging part of a variable impedance transducer in order that small changes be more noticeable. A negative inductance circuit was developed to be used in combination with the variable inductance transducer in the blood pressure sensing circuit. A number of circuit types were investigated, resulting in a simplified oscillator circuit of a type that has apparently not been previously described in the literature. The circuit contains two inductances, the approach of a ferrite core to one increases frequency, and to the other decreases frequency, with extreme sensitivity. The circuit contains few components, and is quite insensitive to voltage changes. It lends itself to the use of a push-pull transducer because of its differential action.

In connection with the blood pressure unit, there have been further developments of the techniques needed for fabricating the transducer. Methods of drilling and shaping ferrite cores have been developed. In particular, it is now possible to fabricate the push-pull transducer configuration that may prove desirable in this application. Some further work has been done on improved fabrication of the bellows structure that will support the moving armature.

It was found that some of the drift in the circuits used for chronic implants was caused by the absorption of body fluids. We now have two months data on the percentage change in weight of samples of a number of plastic types. It may still be desirable to enclose one of these transmitters

in a film of less permeable material, and some water-proof glues have been tested with this in mind. We are presently exploring the possibility of using KEL-F in place of glass in the blood pressure unit.

In this last connection, we are exploring the applicability of the antenna-type used in the under water experiments since the circuit configuration would make radiation from a coil of wire rather ineffective. A few observations on the effective impedance of tissues under the present circumstances have been made so that a reasonable power transfer might be obtained from a current-dipole source.

For use with pH electrodes or oxygen tension electrodes we have been exploring a transmitter circuit with a high input impedance. By using a field effect transistor, incorporated into a second feedback stage, to modulate the frequency of an astable multivibrator, a variable frequency transmitter has been achieved with an input impedance of approximately 500 megohms. Radiation of a signal from this circuit has been demonstrated at acceptable ranges, and improvements in stability against temperature, component, and voltage changes incorporated. Work has been undertaken to reduce the battery drain, but further effort is needed along these lines.

A rather standard type of oxygen electrode has been built and made to work in order to start familiarizing ourselves with the problems of use of such devices.

In attempting to assess the effect of the elasticity of blood vessel walls on the indications of the blood pressure transducer several difficulties were encountered. Our method uses the tonometer probe having a variable plunger extension. It was felt that perhaps the effect of orientation during contact with the vessel might best be assessed by a simultaneous display on an oscilloscope of tonometer reading as a function of instantaneous pressure. It was possible to apply the output of the tonometer to the vertical axis of an oscilloscope

and to compensate the overall system with regard to time delays so that this would match with the output from a Statham gage signal applied to the horizontal oscilloscope axis. Before proceeding further we are making a series of observations on a piece of rubber tubing attached to a mechanical device that generates a pressure wave that somewhat resembles that in an artery. By this means we will be certain that we will be able to use the beating of the heart as a source of pressure changes, rather than having to clamp off a section of artery during the observations on the animals.

During the last visit to Ames we were able to assess the value of the units we had so far supplied to them and to plan how our future work might be helpful to them. They are presently especially interested in temperature, heart rate, and systolic blood pressure as a function of time. They retain a secondary interest in a number of other parameters.

Exploration of an idea for an ingestible EKG transmitter has been instituted. It would accept voltages from the wall of the stomach to modulate a transmitter which would reradiate the signal over the same pair of electrodes. The EMG voltages of the gut could similarly be studied, perhaps as they correlate with pressure fluctuation, stress, etc. Also some consideration has been given to a fragmenting transmitter that could be swallowed but would be too large to pass spontaneously.



"EFFECTS OF VARIED DEGREES OF SENSORY DEPRIVATION ON BRAIN  
CHEMISTRY, BRAIN ANATOMY, AND BEHAVIOR"

NASA Grant  
NsG 154-61

We have completed an initial experiment to test cerebral effects in rats maintained in different degrees of stimulation and social isolation. Measures of brain anatomy and of brain biochemistry reveal significant effects of differential experience. The behavioral phase of a second experiment has now been completed.

Behavioral Phase. Sets of male triplets of the Berkeley S<sub>1</sub> strain were used as subjects. One animal chosen at random from each litter was kept in a complex environment and had training in various mazes and testing devices (Environmental Complexity and Training--ECT--group). Another animal from each litter was housed in an isolated cage in a sound-insulated chamber (Individual Impoverished--II--group). The remaining animal of each litter was housed with another animal in a cage in the sound-insulated chamber (Paired Impoverished--PI--group).

Anatomical and Chemical Phase. At the end of the 80-day experimental period, five standard samples of brain tissue were taken from each subject. These samples were assayed for activity of the enzymes acetylcholinesterase, cholinesterase, and hexokinase. The persons who removed the brain sections and who conducted the chemical analyses did not know to which group any animal belonged.

Results. The isolated impoverished (II) group had significantly greater adrenal weights than the ECT group. Even the animals raised in pairs in the impoverished environment (PI) group showed some enlargement in adrenal weight compared with the ECT animals. These results indicate that the animals

in the impoverished environment were under stress and that pairing animals did not completely overcome the stress.

The impoverished environment animals showed significant decreases in brain weight, especially in the cerebral cortex, when compared with their ECT littermates. The pattern of changes among cortical regions was somewhat different from those of previous experiments where the degree of impoverishment was not as great as the present case. The dorsal cortex of the ECT animals was about 10 percent heavier than that of the II group.

There were significant differences in total activities of all three enzymes, but these were largely determined by the weight differences, and group differences in enzymatic activity per unit of brain weight tended to be small.

Replication. The replication experiment included the three groups of the original experiment -- ECT, PI, and II -- plus a fourth group. The additional group consisted of animals maintained in pairs in the same room as the ECT group. The behavioral phase of the replication experiment was completed at the end of June, and chemical analyses of the brain samples are in progress.

"THEORETICAL AND EXPERIMENTAL EVALUATION OF  
INELASTIC NEUTRON SCATTERING AND OTHER NEUTRON  
INDUCED REACTIONS FOR REMOTE SURFACE ANALYSIS"

NASA Grant  
NsG 452

Mr. Michael Yates, a graduate student in the Department of Nuclear Engineering, has started to work on a neutronics project concerned with studying the detailed behavior of fast neutrons as they slow down in matter. It is hoped that this work will enable us to draw some conclusions regarding the most effective way of using energetic neutrons to perform soil sample analysis.

On June 23, 1964, a meeting was held at NASA Headquarters in Washington, D. C. to discuss progress in the development of neutron sources. Dr. Waggoner attended the meeting as our representative. The neutron source necessary to perform inelastic scattering experiments is in existence and is adequate for the purpose. Specifications for neutron sources necessary for neutron activation experiments were also discussed. More experimental work will have to be done before a decision can be reached regarding the choice between activation analysis and fast neutron scattering as the best method for performing an analysis of remote surfaces.

"FLUID MECHANICS, THERMODYNAMICS AND HEAT TRANSFER"

NSF Grant  
NSF GP-2103  
NSF GP-2520

During the period of this report work under this grant continued in three areas: Turbulence, aerodynamics of oscillating cylinders, and flow visualization in rarefied gases. Work was also begun on three dimensional effects in underwater explosions.

In the area of turbulence, theoretical work on the linear model of the viscous sublayer has proceeded satisfactorily. Numerical results obtained with the 7090 computer are qualitatively adequate and an analysis of the effect of a flexible wall on a given turbulent flow is in progress. A detailed experimental study of the turbulent boundary layer over a longitudinal screen is in progress.

The calculation of the pressure coefficient on a vibrating cylindrical shell of finite length in supersonic flow was completed. The expression is valid at high values of Mach number and low values of vibration frequency. This is now being incorporated in a revised analysis of cylindrical panel flutter. The effect of a vertical density gradient on the initial behavior of a spherical explosion is being investigated by a theoretical analysis, applicable for short times after detonation.

The new sodium seeding apparatus has proved to be effective and reliable over a period of about two months of evaluation. During this period other elements of the resonance scattering system have continued in development and a number of illuminating photographs of free jet expansion under conditions of high pressure ratio and low Reynolds number have been obtained.

## PROPULSION DYNAMICS

Work on:

"DETONATION STUDIES OF MIXTURES OF GASEOUS HYDROGEN AND GASEOUS OXYGEN", NASA Contract NAS 8-2634

"GAS-WAVE-DYNAMIC STUDIES OF SPRAY COMBUSTION"  
NASA Grant NsG 702

"DEVELOPMENT AND STABILIZATION OF DETONATION", AFOSR Grant AF 129-64 (Administered by Institute of Engineering Research)

"REACTION KINETICS OF ACCELERATING FLAMES", NASA Grant NsG 10-59 (Administered by Institute of Engineering Research)

### DETONATION STUDIES -- NASA Contract NAS 8-2634

Additional funds for the continuation of the test program involving the detonability of hydrogen-oxygen mixtures in large vessels with initial temperatures ranging from -200 to + 200<sup>0</sup> F and sub-atmospheric initial pressure down to 1 mm Hg have been received by the University on June 25.

Preparatory work for the resumption of the test program is underway.

Two students working on this contract graduated with M. S. degrees.

### GAS-WAVE-DYNAMIC STUDIES OF SPRAY COMBUSTION -- NASA Grant NsG 702

The purpose of this research program is the study of the generation of pressure waves by flames in heterogeneous, gas-liquid mixtures. We have just been informed that the University received the funds, so there is no progress to report at this juncture.

### DEVELOPMENT AND STABILIZATION OF DETONATION -- AFOSR Grant AF 129-64

Studies performed recently include a refined analysis of the initial flame acceleration in an equimolar hydrogen-oxygen mixture ignited by a glow coil in a 1 x 1-1/2 inch cross-section detonation tube and the investigation of the

interaction process between the flame and the shock wave.

In this connection the following manuscripts have been prepared:

1. "Dynamics of the Generation of Pressure Waves by Accelerating Flames", to be presented at the Tenth Symposium (International) on Combustion, Cambridge, England, August 17-21, 1964.
2. "Gasdynamic Effects of Shock-Flame Interactions in an Explosive Gas", to be presented at the American Institute of Aeronautics and Astronautics Summer Meeting, Washington, D. C. , June 29-July 2, 1964.

As a result of earlier studies the following publications have appeared in print:

1. "Long-Duration Spark Light Source for Streak Schlieren Photography of High-Speed Events", ISA Transactions, 3, 2, 100-107, April 1964.
2. "Pressure Wave Generated in a Fissionable Gas By Neutron Irradiation", Physics of Fluids, 7, 5, pp 676-683, May 1964.

Degrees received by the students who were supported by this grant include one M. S. and one Ph. D.

#### REACTION KINETICS -- NASA Grant NsG 10-59

All the work associated with this research program has been completed.

The most recent achievements have been described in the following manuscript:

1. "Detonation Velocities in Ozone", to be presented at the Tenth Symposium (International) on Combustion, Cambridge, England, August 17-21, 1964.

The final report is now in preparation. A Ph. D. degree was received by the last student supported under this grant.

DETECTION AND STUDY OF MICROORGANISMS  
IN THE UPPER ATMOSPHERE

NASA Grant  
NsG 104-61

Tests to evaluate an electrostatic precipitator for use in high altitude microbial sampling are continuing. Bacterial recovery efficiencies at atmospheric pressure using aerosols of Bacillus subtilis have thus far been low. To improve this situation, it was decided to use dry preparations of bacteria for sampling by the electrostatic precipitator. Theoretically this would eliminate difficulties encountered with aerosols and would more closely simulate the testing conditions to be encountered during an actual flight. Acetone-dried preparations of B. subtilis are being used in these tests. The aerosol chamber has been modified to include a compressed gas gun for introducing these dry samples.

The relative concentration of viable organisms in the air samples is determined by using Anderson Samplers. The testing apparatus has been modified so that more consistent and reliable data can be obtained. Flow control valves and conduits have been modified for easier handling during testing and a symmetrical fitting has been designed and installed on the aerosol chamber to improve the dependability of the splitting of the air flow from the chamber to the electrostatic precipitator and to the control sampler. A manometer is also being used throughout the testing period in order to monitor and allow for the regulation of the relative air pressure in both sampling streams. Thus far these modifications in the test apparatus have shown that continued regulation of the air flow during sampling is necessary as the rate of flow is extremely sensitive to slight variance

in pressure in the aerosol-dust chamber or a variance in the level of the bacteriological media in the Anderson plates.

The efficiency of recovery of dry bacteria by the electrostatic precipitator will be measured when stability and reliability of the experimental method and apparatus has been achieved.



## "INVESTIGATION OF KILOVOLT ION SPUTTERING"

NASA Contract  
NAS 3-5743

The cesium ion beam ultra high vacuum system has been fabricated and assembled. This system is currently being leak checked. Preliminary measurements indicate that the metal-metal flanges are suitable for attaining the desired pressures. The cesium ion source target and collector holders have been delivered and will be mounted following successful leak checking.

An electropolishing technique for reduction of single crystals of molybdenum has been developed. X-ray orientation measurements will be made which will be followed by neutron activation and gamma spectrum measurement.

A target holder suitable for accurate target temperature control up to the melting point of aluminum has been designed and is now being fabricated. The target, although heated, is electrically isolated which will allow ion current measurements to be made during the sputtering process.

An argon ion source has been built to operate in a second vacuum system which is currently operational. The electronics for chopping and focusing this beam have been built and tested. Actual experimentation with the beam will begin shortly.

Preliminary measurements, using a third vacuum system which is nearing completion, will be made on the pulse characteristics of a bakeable electron multiplier which has been delivered. The high speed counting gear needed for this operation has been delivered, checked, and mounted.

A final vacuum system is under design. This system should be suitable for operation in the  $10^{-10}$  range and will be used to develop the technique of electron desorption for measurement of surface contamination before and after

ion bombardment of the crystal surface. These experiments will be made with a new quadrapole mass spectrometer which will be delivered in August. The spectrometer will also be used in conjunction with the argon beam in order to detect both neutral and ionized particles ejected from the bombarded surface.

"CONTRIBUTIONS TO SURFACE MAGNETIC FIELDS FROM  
SOURCES INTERNAL AND EXTERNAL TO THE EARTH"

ONR Contract  
Nonr 222(89)

A. Atmospheric, Ionospheric, Exospheric Physics

Field Experiments

One cooperative micropulsation recording period has been organized for the period 20-27 July, 1964. Cooperating stations include Austin, Texas; Vancouver, B. C.; College, Alaska; Fredericksburg, Maryland; and Palisades, New York. In addition, the forthcoming trip to Flin Flon, Manitoba will enable us to correlate our records obtained there with the above-mentioned stations. Thus, during the summer, we will record both mid-latitude and auroral zone phenomena simultaneously with other geographically distributed stations. Data reduction for all stations will be performed at Berkeley.

Theoretical Work

Dr. Ross Lomanitz is trying to make more quantitative an idea recently proposed by Dessler and Walters on a mechanism by which energy from the solar plasma might be converted into hydromagnetic waves in the Earth's magnetosphere. In two papers they propose (a) that the steady state shape of the magnetosphere is asymmetric relative to the solar wind velocity and (b) that the angle of "tilt" varies with time. By analogy with production of sound waves, they predict that this should lead to the generation of hydromagnetic waves. We propose to see whether we can find some sorts of unstable solutions of the Vlasov Equations under the conditions they suggest. If successful, a more solid basis than acoustical analogy could be provided for their mechanism, and also perhaps a quantitative one.

B. Solid Planetary Physics

Magnetotellurics

The study of electromagnetic impedances at the surface of a homogeneous layered earth is presently being extended to include simple inhomogeneities. The electromagnetic response of a conducting cylinder in a dissipative half space is being studied, and this work will be extended to cylindrical structures (anticlines, etc.) at the boundary between two conducting layers.

An approximate method of evaluating the effects of source dimensions has been developed, but this problem is still being investigated. Frank Morrison, Douglas O'Brien, and Roger Phillips, Ph.D. candidates, are conducting the theoretical and experimental studies.

Transient Magnetic Variations, Permeability Environment

N. E. Goldstein and R. Phillips have been carrying on field work, using Goldstein's techniques, in the detection of ferromagnetic inhomogeneities using natural micropulsation sources. Theoretical studies are being carried out concerning the secondary micropulsation fields associated with these inhomogeneities, in both conducting and non-conducting surroundings. Goldstein's Ph.D. thesis on this subject is nearing completion.

## "SECULAR CHANGE AND THE ORIGIN OF THE DIPOLE FIELD"

CGS Grant  
CGS-1167(G)

Besides a continuous completing of the card index about the title subject and adjacent fields, a preliminary result of the first special problem mentioned in the last report, with respect to the local magnetic constant  $G$ , has been obtained.

There can be drawn no conclusions from any  $G$  or  $dG/dt$ -chart upon the real depth of the non-dipole sources or those of the secular variation. These charts present no solid objection against the most probable assumption for the depth of at least the non-dipole field and its secular variation to lie in the outermost layer of the Earth's core.

In the quantitative investigation of a rotating spherical conductor the similitude laws have been worked out which would be required for a laboratory model of the Earth's core with respect to its magnetic features. Such a model, however, seems to be extremely difficult because of the necessity of an extremely high conductivity.

The theory of a rotating spherical conductor shows very clearly that a certain "magnetic eigen mechanism" exists, providing a dipolar field outside the sphere with an alternating sign. These steady-state solutions are now being further investigated.

This research is being conducted by Dr. Joachim Meyer, Coast Survey postdoctoral fellow from Geophysikalische Institut, Universitat der Gottengen, Germany.

"THE EFFECT OF THE IONOSPHERE ON  
ATTENUATION OF 'PEARL' ACTIVITY"

NSF Grant  
NSF GP-1775  
(IQSY Project)

Experimental

Minor modifications have been made in the previously described system to improve reliability. Routine operation procedures have been established and the system turned over to a laboratory assistant. Plans are being formulated for conversion of an inexpensive stereo tape deck for use as a recording medium.

A computer program for the monthly analysis of riometer records has been completed. The program computes the ionospheric disturbance absorption in decibels as a function of time of day for each day of the month. Telluric records for April and May have been scanned in a preliminary fashion and pearl events identified.

Attempts to use the monthly disturbance absorption to explain the occurrence of pearl activity have not been successful. This result is not significant, however, as the percent errors in the calculations are quite large. This error is inherent in the method and is a consequence of the negligible disturbances occurring at middle magnetic latitudes. Further comparisons of this nature will be made when sufficient information is available to calculate the total absorption.

A re-examination of riometer and telluric records, with particular emphasis on fine structure, will be made this summer. In particular an attempt will be made to relate events on both records to other sources of geophysical information.

### Theoretical

The theoretical aspects of the problem will be examined in two stages: (1) the propagation of pearls through the ionosphere and (2) the origin of pearls. To examine the ionospheric effects on propagation a highly simplified model has been assumed. On a basis of this model the transfer function for the ionosphere is to be calculated. Two major problems have been encountered. The first arises due to the effects of the Earth on electromagnetic measurements made at its surface. This problem has been solved for the chosen model and is now being programmed for the computer. The second difficulty is the lack of information on the input to the ionosphere. A preliminary approach to the solution of this problem will be made this coming fall when a cooperative experiment will be performed in conjunction with the Cosmic Ray Group.

The question of origin of pearls is being deferred until more information on their characteristics is acquired. At the present time a comprehensive survey of the literature is being made. R. L. McPherron, Ph.D. candidate, is conducting the majority of the research.

## INFRARED PLANETARY OBSERVATORY IN THE STRATOSPHERE

NASA Grant  
NsG 255-62

Proposal UCB SSL No. 169, "A Study of Advanced Infrared Detectors For Use In Planetary Spectroscopy", has been accepted by NASA. Equipment procured under NsG 255-62 will be used in this study. Current efforts are aimed at planning observational programs using this equipment which will yield performance data on the detectors as well as new observational data.

Evaluation of the bolometer-detector performance from data taken before and after the first flight of Stratoscope II has been completed; the information is currently being applied to the flight data. This work is principally applicable to NsG 255-62 (S-2) "A Proposal for a Review of Stratoscope II Infrared Observations of Mars", but will also enable completion of the final report for NsG 255-62.

The above work has been supported by NASA Grant NsG 243-62, "General Support", during this quarter due to the considerable delay of about six months between scientific approval and actual funding of NsG 255-62 (S-2).



## SURFACE IONIZATION AND ELECTRON EMISSION FROM REFRACTORY METALS

A. E. C. and  
University Funds

The following research is being supervised by Professor Thomas H. Pigford. The particular research reported herein is an outgrowth from a program of nuclear materials research carried out by Professor Pigford under support of the U. S. Atomic Energy Commission.

An experimental investigation of the effects of adsorbed cesium on the thermionic emission and surface-ionization properties of planar single crystals of tungsten and rhenium, as a function of crystallographic orientation, is underway. Test diodes with variable spacing of parallel electrodes have been constructed. Tests are now underway with an emitter of monocrystalline tungsten oriented with the (110) direction normal to the surface. A replacement emitter of tungsten with (100) orientation has been prepared. The tungsten experiments are being carried out by Mr. Daniel Koenig.

Ronald Wichner is now developing techniques for preparing monocrystalline rhenium emitters. Discs of monocrystalline rhenium 0.625 in. in diameter have been cut parallel to the basal (0001) plane and planed using a Servomet spark cutter to avoid surface deformation of the crystalline lattice. Niobium brazing of the rhenium crystal to a tantalum support is now being attempted. A vacuum furnace for electron brazing at temperatures up to 2700°C has been constructed.

H. C. Carney is completing an experimental study of the effectiveness of surface ionization of cesium, rubidium, and potassium in neutralizing electron space charge in thermionic diodes operating as energy sources. The results appear to agree very well with the theoretical predictions for collisionless plasmas.

## INTERACTION OF ALPHA PARTICLES WITH SEMICONDUCTORS

A. E. C. and  
University Funds

Mr. Lawrence D. Posey is conducting experiments to study the effects of alpha-particle irradiation of semiconducting diodes. Radiation-induced changes in operating characteristics, carrier concentration and lifetime, and energies to produce electron-hole pairs are being measured. These properties are pertinent to the possible application of semiconducting diodes to convert the kinetic energy of incident charged particles directly to electrical energy. Silicon solar cells (p on n) are exposed to an  $\text{Am}^{241}$  alpha source. Irradiations have been carried out at  $200^{\circ}\text{K}$  and  $275^{\circ}\text{K}$  for three values of incident energy flux. A conversion efficiency of two percent has been obtained at  $200^{\circ}\text{K}$ , with considerably lower efficiency at  $275^{\circ}\text{K}$ , consistent with theoretical predictions. Also in agreement with theory is the observed effect of incident energy upon the induced degradation in diode performance. No temperature dependence on this degradation has been detected.

Additional apparatus has been constructed to study the effects of alpha irradiation on n-on-p silicon and p-on-n gallium-arsenide solar cells. Studies are also underway to investigate the process of electron-hole pair production in silicon by alpha particles and to ascertain the mechanisms which determine the dark current-voltage characteristics of these solar cells.